CNS: An Integrated Vision for the Future

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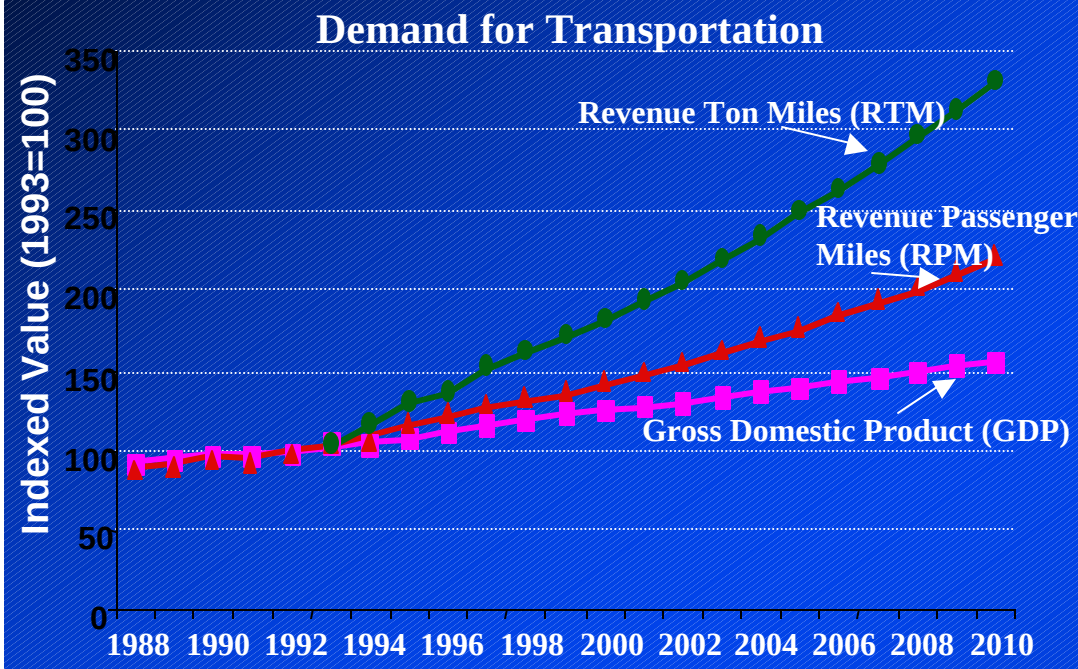
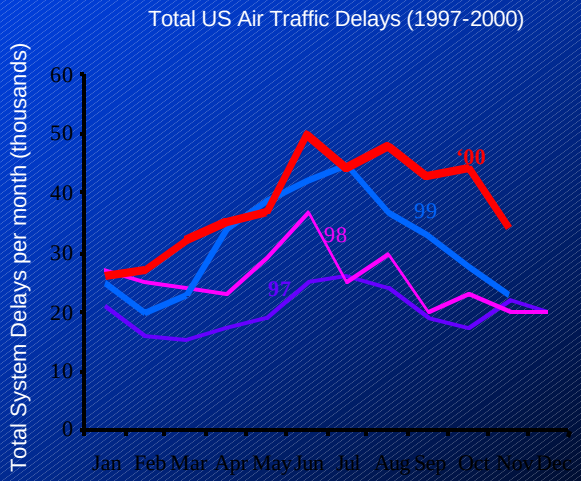
Aviation Gridlock



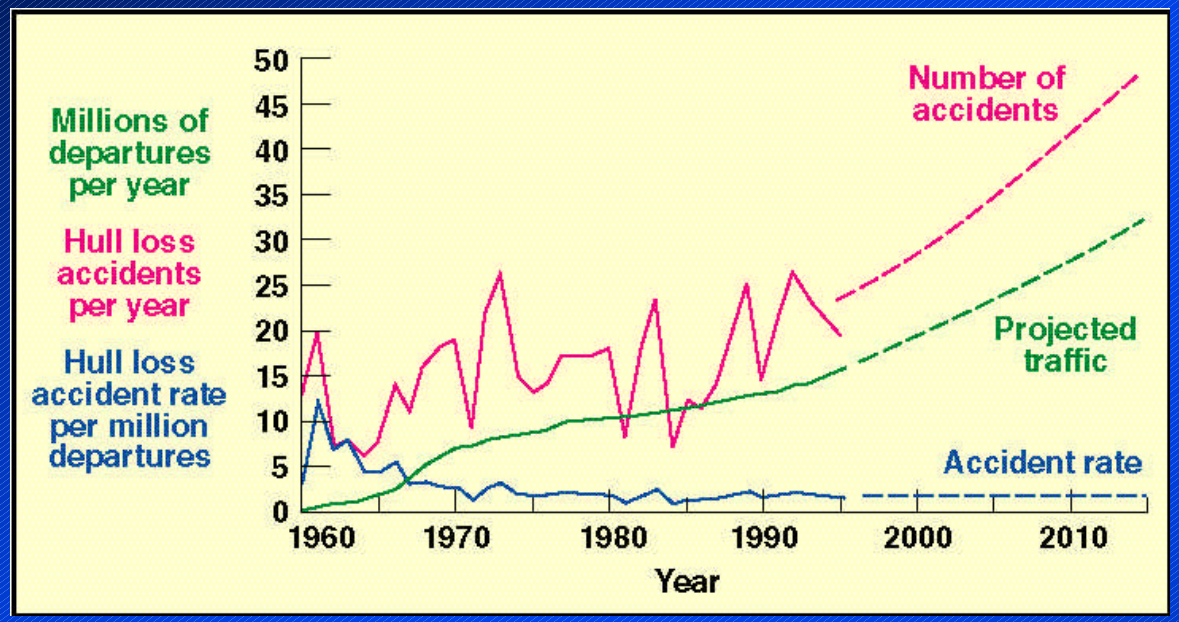
Demand is growing...

Delays are climbing...



The Capacity & Safety Challenge

Air Traffic to Triple in Next 20 Years



Technology Objectives:

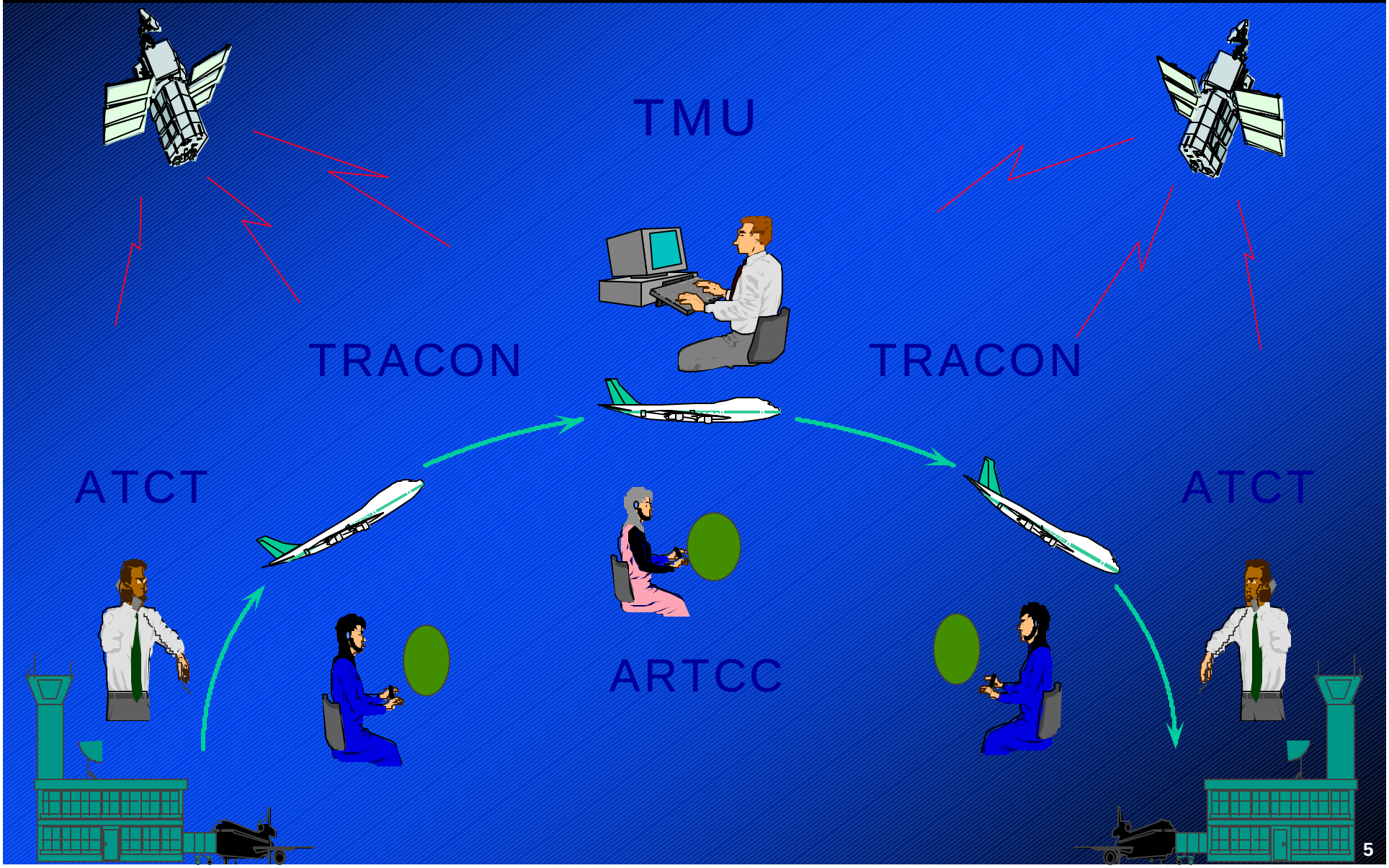
- Double the capacity of the aviation system within 10 years and triple it within 25 years
- Reduce the aviation accident rate by a factor of 5 within 10 years, and by a factor of 10 within 25 years

The current air traffic management system is near its capacity limits with extensive system delays and inefficiencies resulting in annual losses to users estimated at over $4.5B.

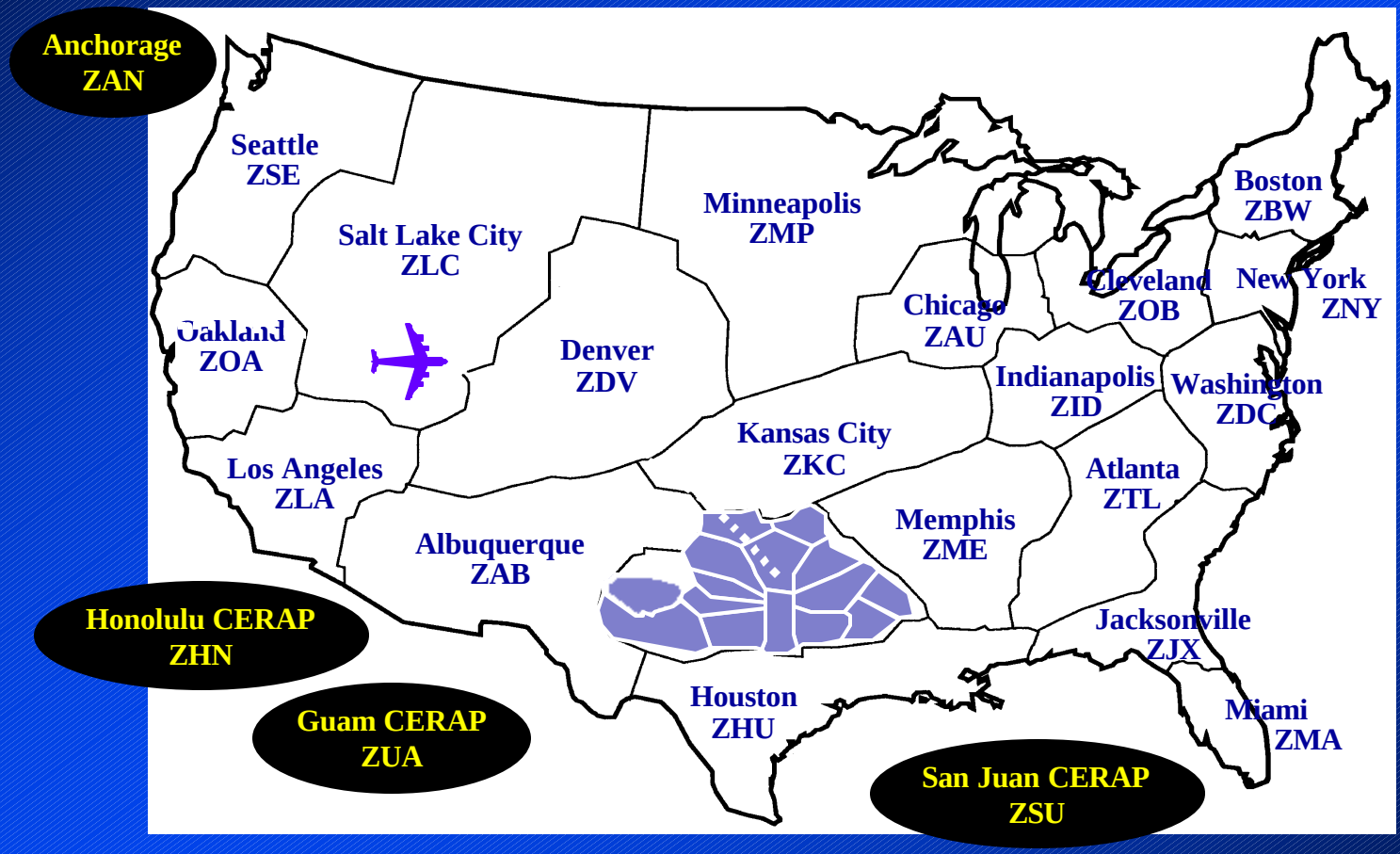
Some Key Reasons Why

- Operational Issues
  - Labor-intensive, manual Air Traffic Control (ATC)
  - Minimal automation
  - Inflexible airspace procedures
  - Ultimately limited by air traffic controller workload
- Infrastructure Issues
  - Dated communications, navigation and surveillance systems
  - Limited number of runways (at major hubs)
- Other factors
  - Extremely conservative community (slow to change)
  - Highly complex operations (most complex in the world)
  - Large number of stakeholders (difficult to reach concensus)
  - Regulatory issues (environmental, certification, political…)

Air Traffic Control System

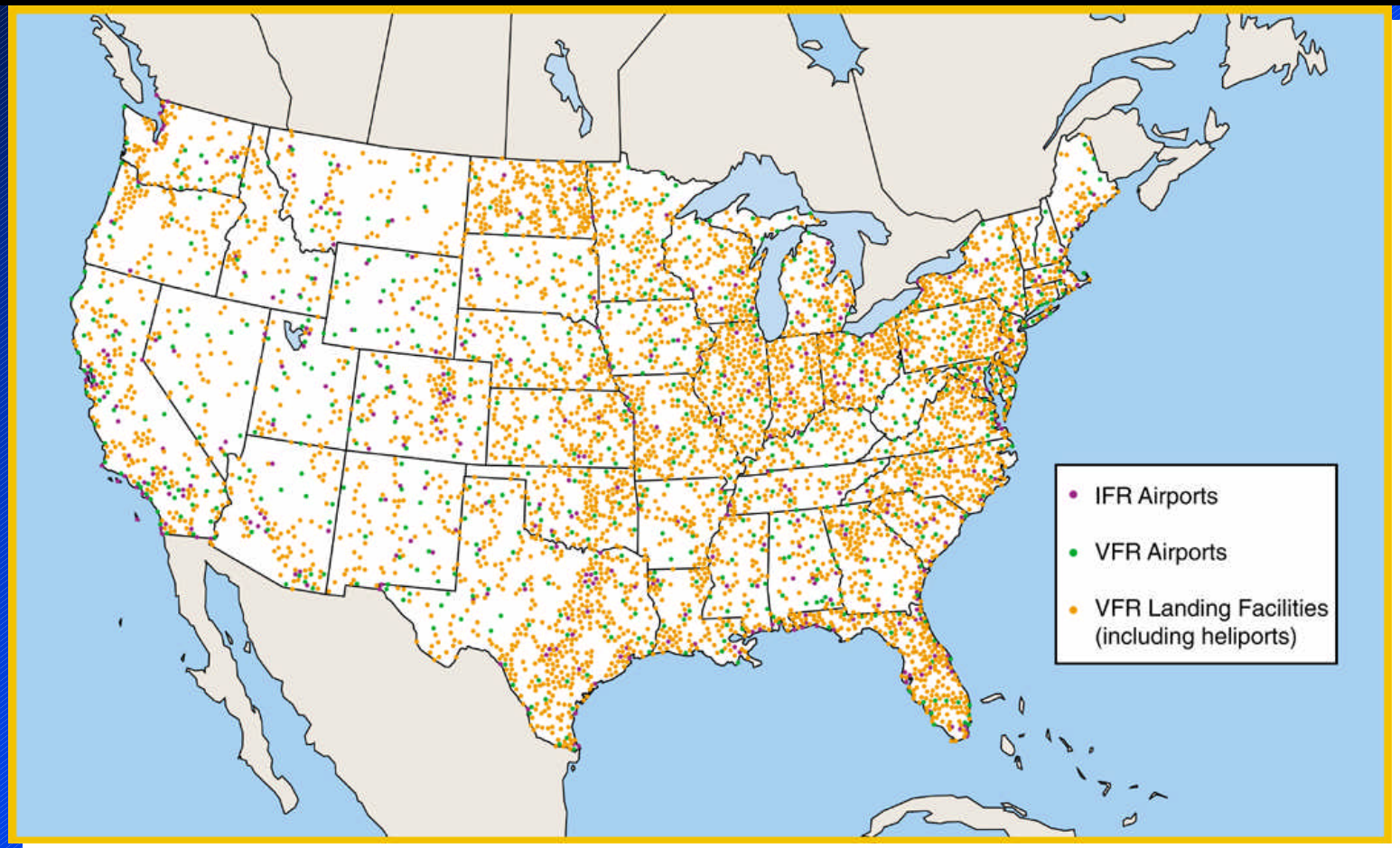


Air Traffic Control Centers



A typical flight across the US crosses 7 ATC Centers and communicates with over 25 air traffic controllers

Limitations: Hub & Spoke Ops & Legacy Infrastructure



5400 Public Use Airports

715 Airports with Precision Instrument Approaches (ILS)

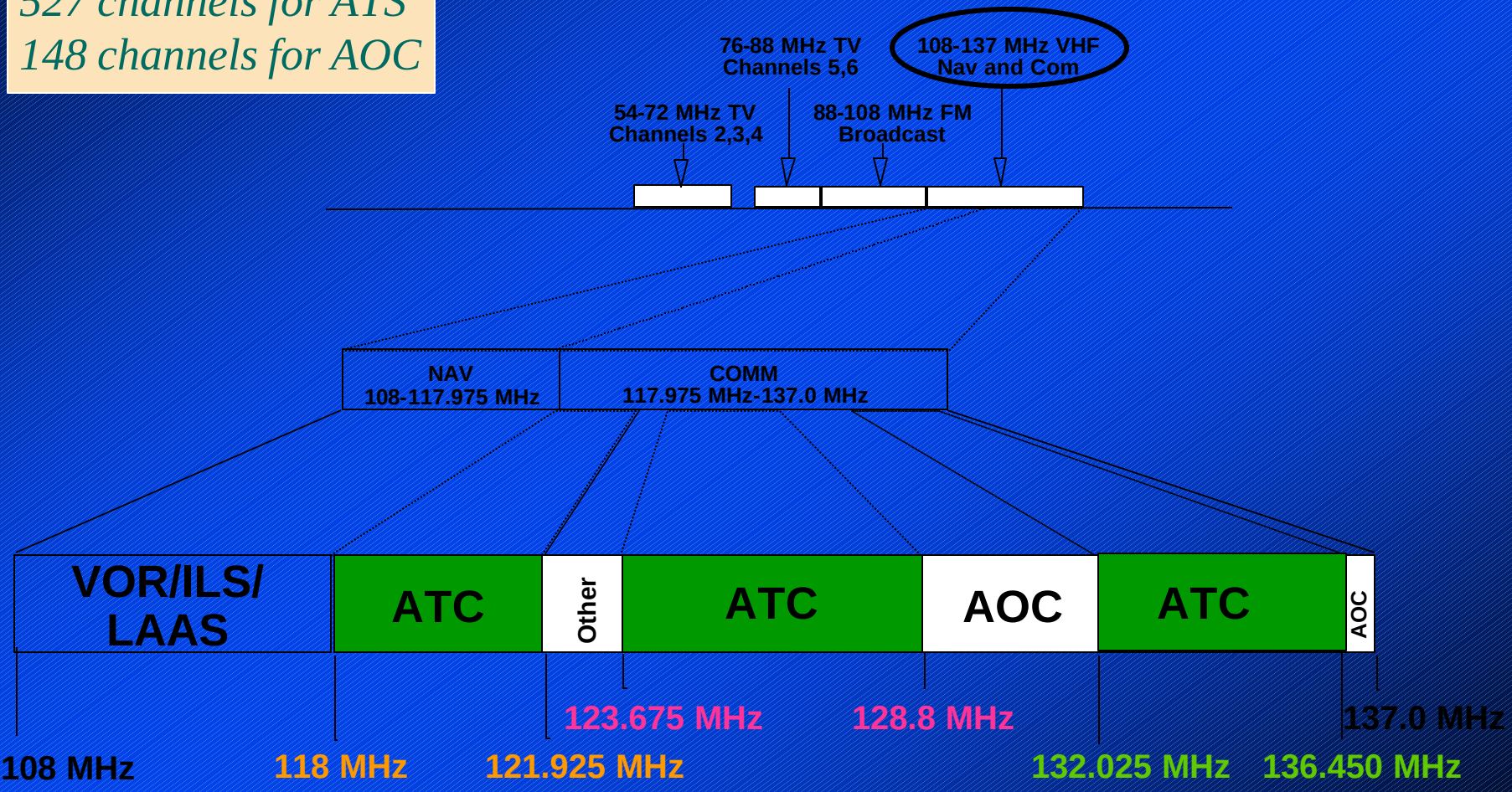
Top 64 Hub Airports Enplane 80% of all Passengers

Current Communications, Nav & Surveillance (CNS)

- Communications
  - Analog voice
  - 25KHz channels, double sideband AM Radio
  - In protected aeronautical comm VHF band (118-137 MHz)
- Surveillance
  - Radar-based, 'independent' surveillance
    - Primary and secondary surveillance radars
    - Airport surface radars
  - Airborne transponder for controlled airspace (ID tag & altitude)
- Navigation
  - Ground-based navigational aids
    - VHF Omnirange (VORs), Distance Measuring Equipment (DME)
    - In protected aeronautical navigation VHF band (108-118 MHz)

Current Aero VHF Spectrum

527 channels for ATS
148 channels for AOC



Current FAA Radio Infrastructure

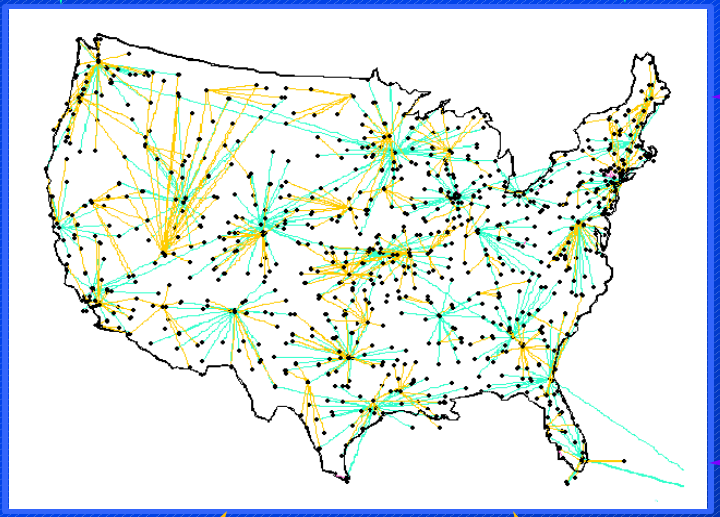
Air Route Traffic Control

~ 22 ARTCCs and 682 RCAG

Remote Communications Air/Ground (RCAG)

Terminal Facilities:
- TRACON
- Airport Tower Traffic Control (ATCT)

- VHF and UHF ATC bands
- Approximately 12,000 frequency assignments (Total, as of 1997)
- 46,000 radios (Transmitters, Receivers, Transceivers)
  - 39,000 older ITT radios (VHF & UHF)
    - 23,000 VHF
    - 16,000 UHF
  - 7,000 newer Motorola radios (VHF & UHF)
    - 4,000 VHF
    - 3,000 UHF
- 700 BUEC Replacements (operating)



~175 TRACONs, 480 ATCTs, and 1294 RTRs

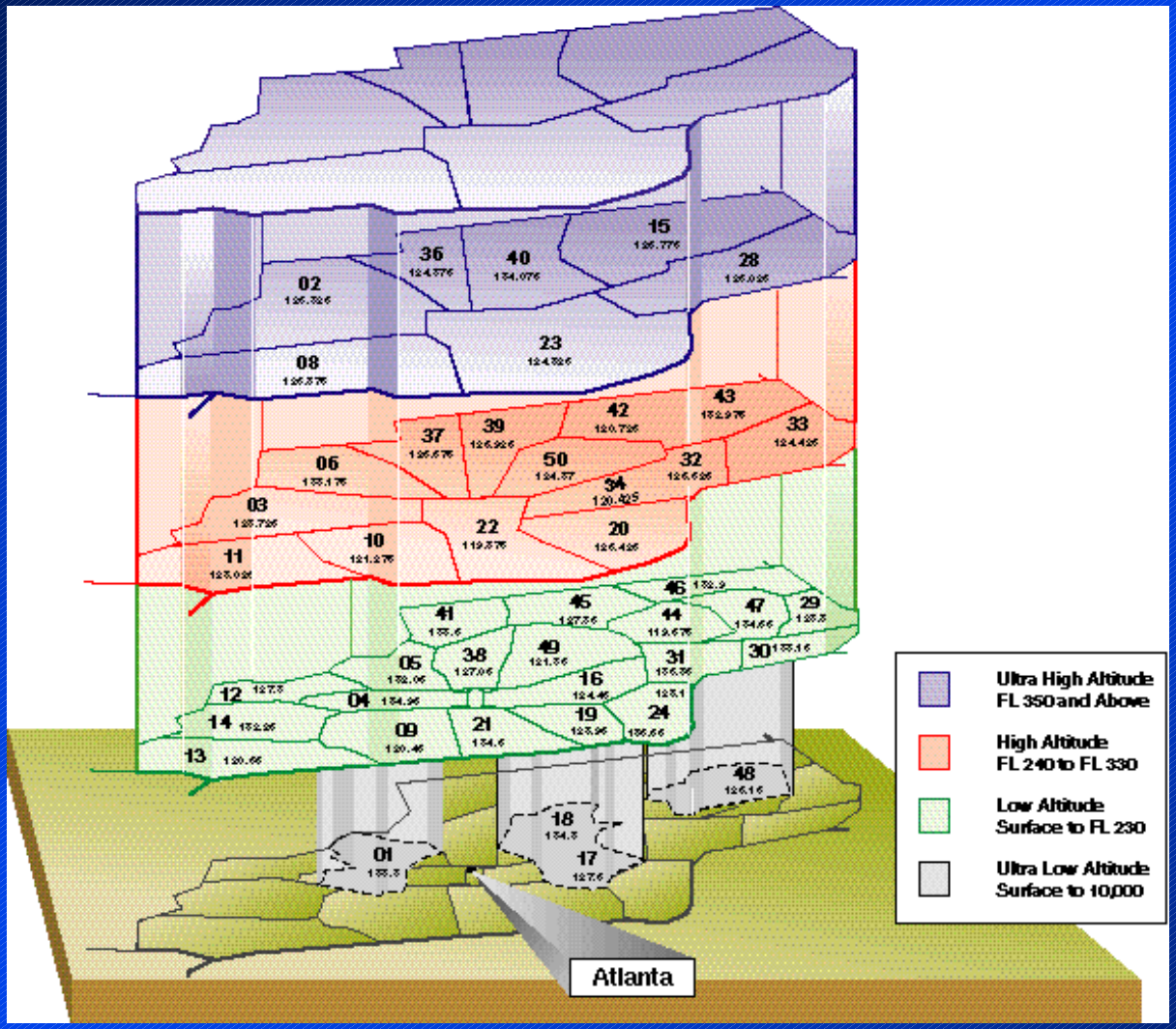
Remote Transmitter/Receiver (RTR)

Automated Flight Service Station (AFSS)

~ 61 AFSSs and 1738 RCOs

Remote Communications Outlet (RCO)

Frequency Map: Atlanta Center

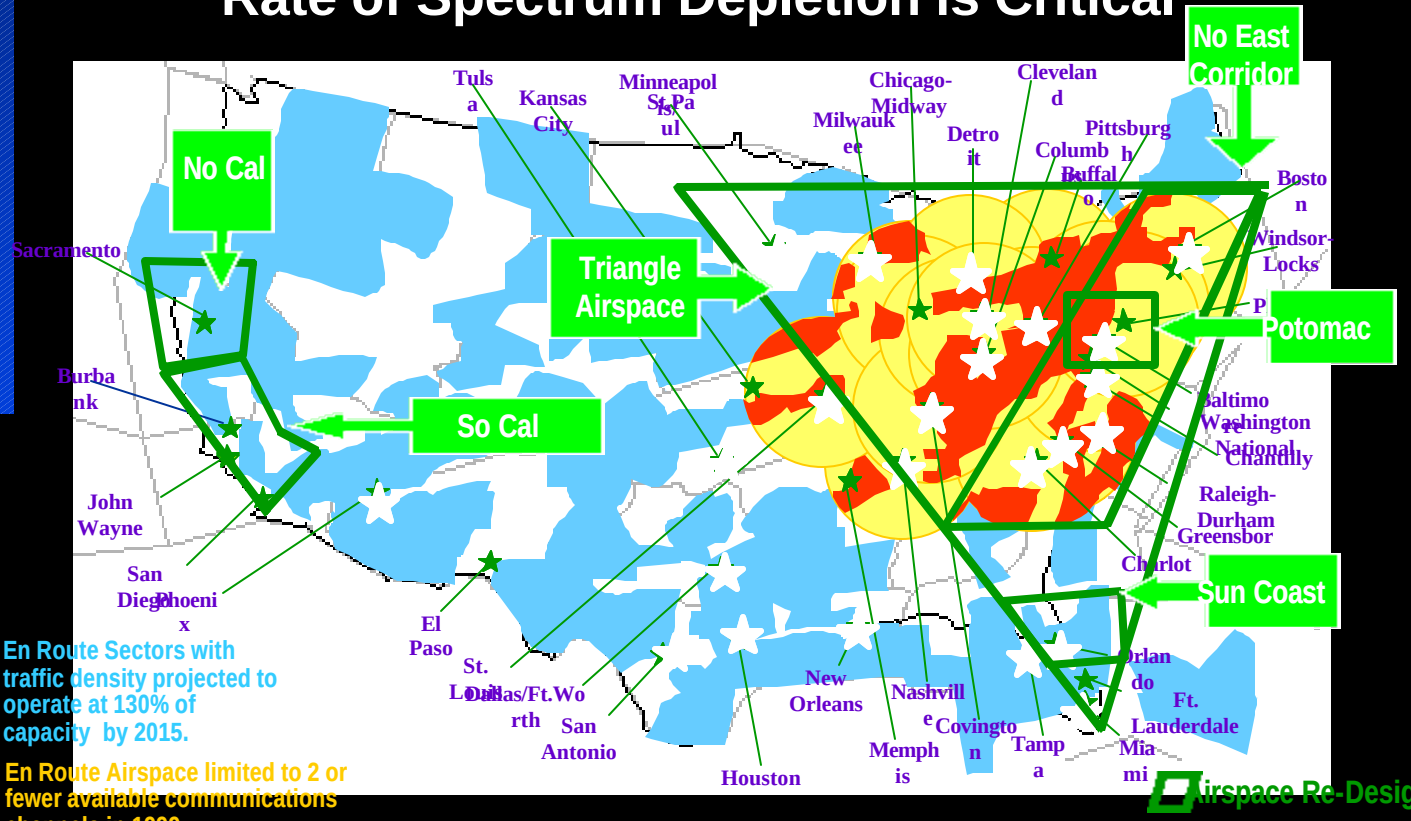


NOTE: each sector has a frequency protected VHF assignment

Running Out of Spectrum…

The end is 2010. Need a long-term plan.

Rate of Spectrum Depletion is Critical



En Route Sectors with traffic density projected to operate at 130% of capacity by 2015.

En Route Airspace limited to 2 or fewer available communications channels in 1999.

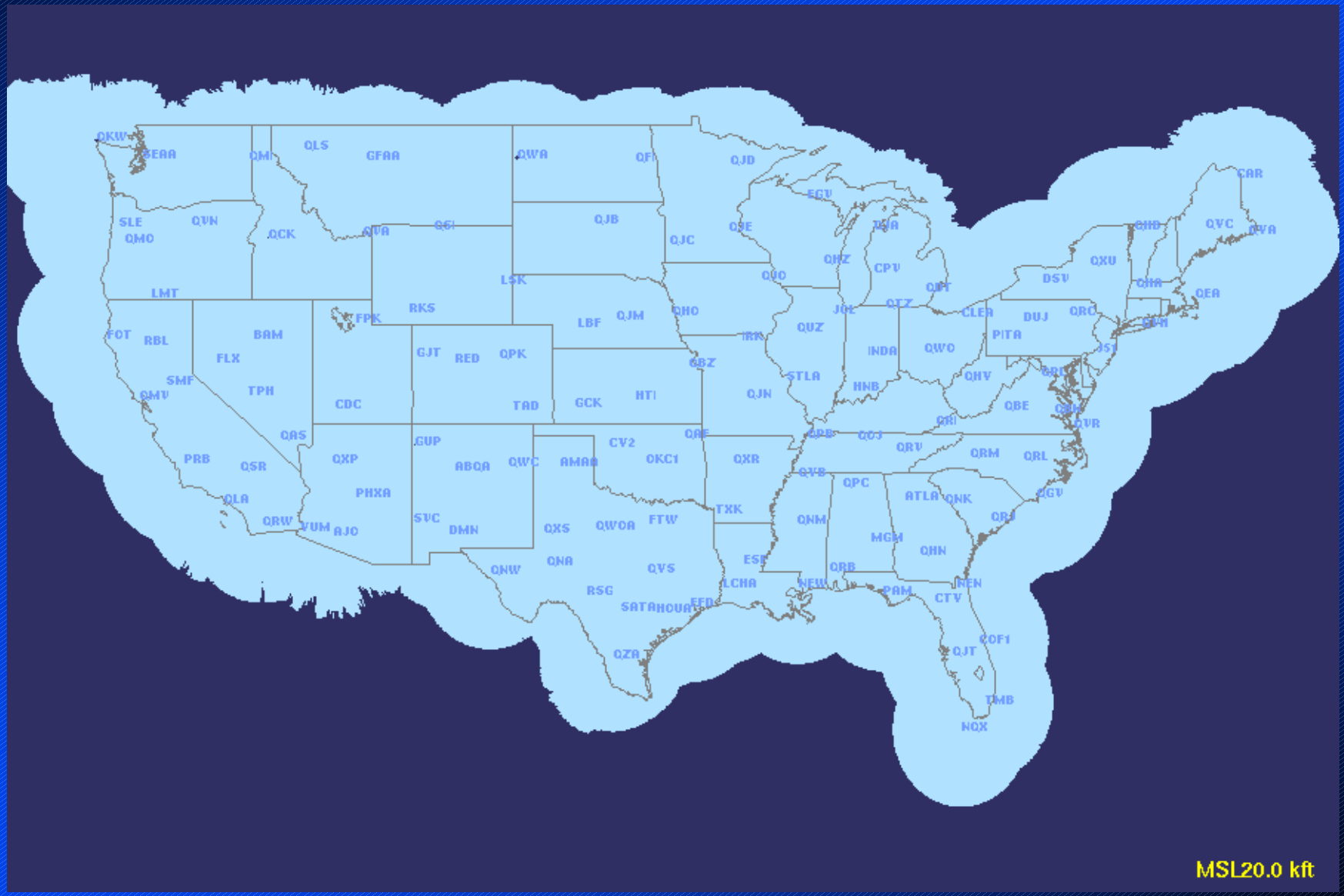
Lack of available channels in these busy En Route sectors can result in delays

★ Airports limited to 4 or fewer available communications channels in 1999.

★ Lack of available channels in terminal areas, planning runway expansions can result in delays

2015 En Route Traffic Projection with Current VHF Communications Channels

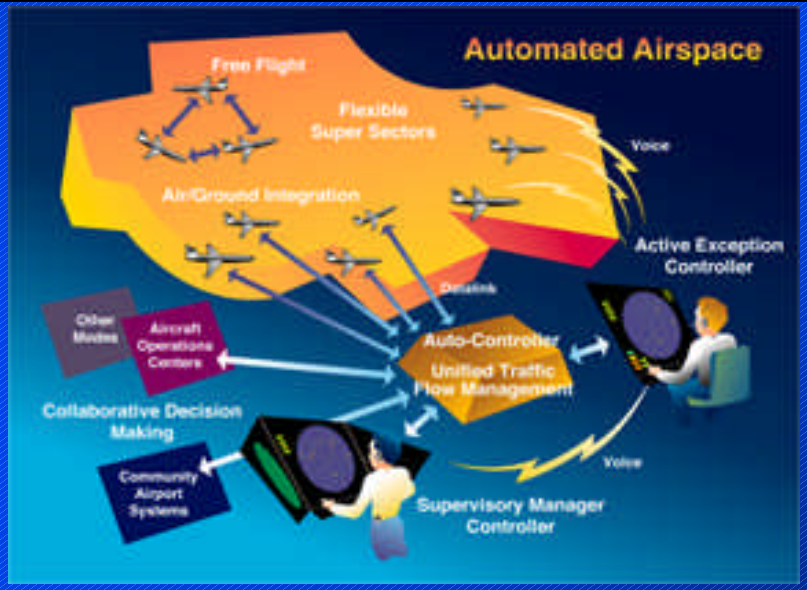
FAA CONUS En-Route Radar Coverage (@ FL 200)

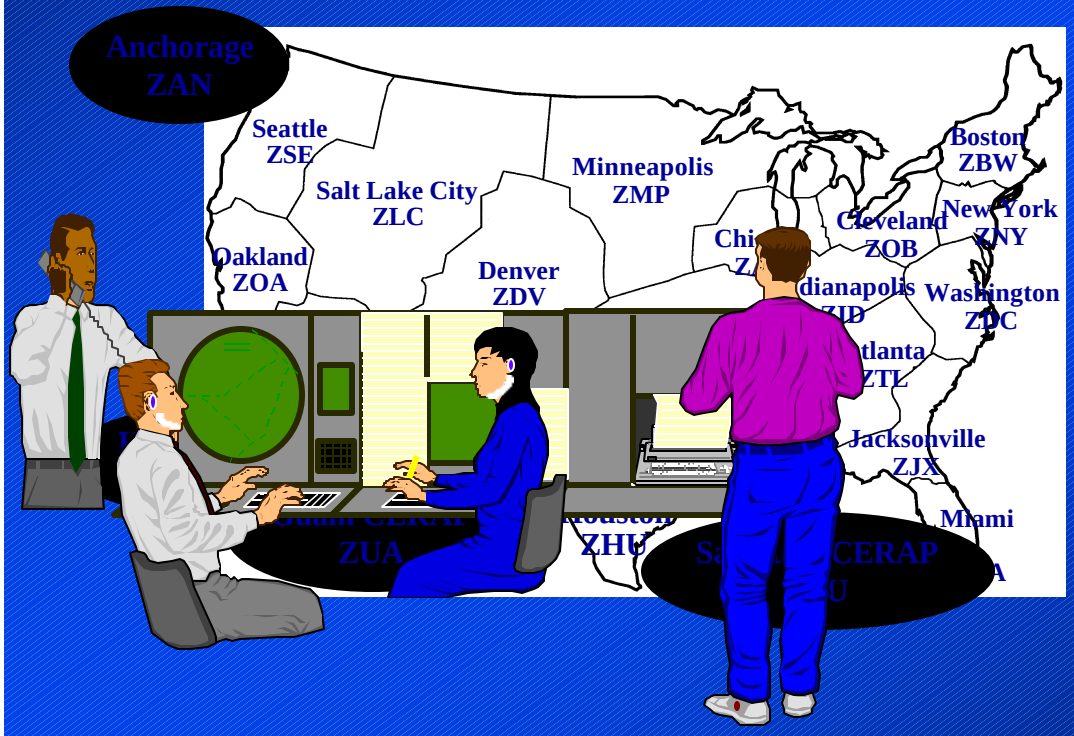


MSL20.0 kft

ATC: Now and in the Future

Tomorrow… strategic management of the airspace with aircraft self-separation and air - ground collaborative decision making - *an integrated, scalable approach*





Today… highly compartmentalized radar surveillance and control of aircraft separation - *a hierarchical, self-limiting approach*

A Revolutionary Approach to ATM

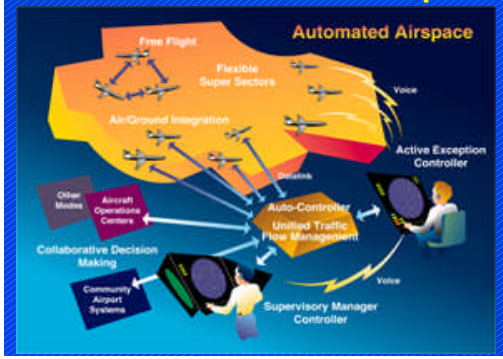
Robust, global systems
Precision approach to every runway in the U.S.
System-wide information sharing

Advanced, Global Communication, Navigation & Surveillance

Distributed & High Capacity Infrastructure

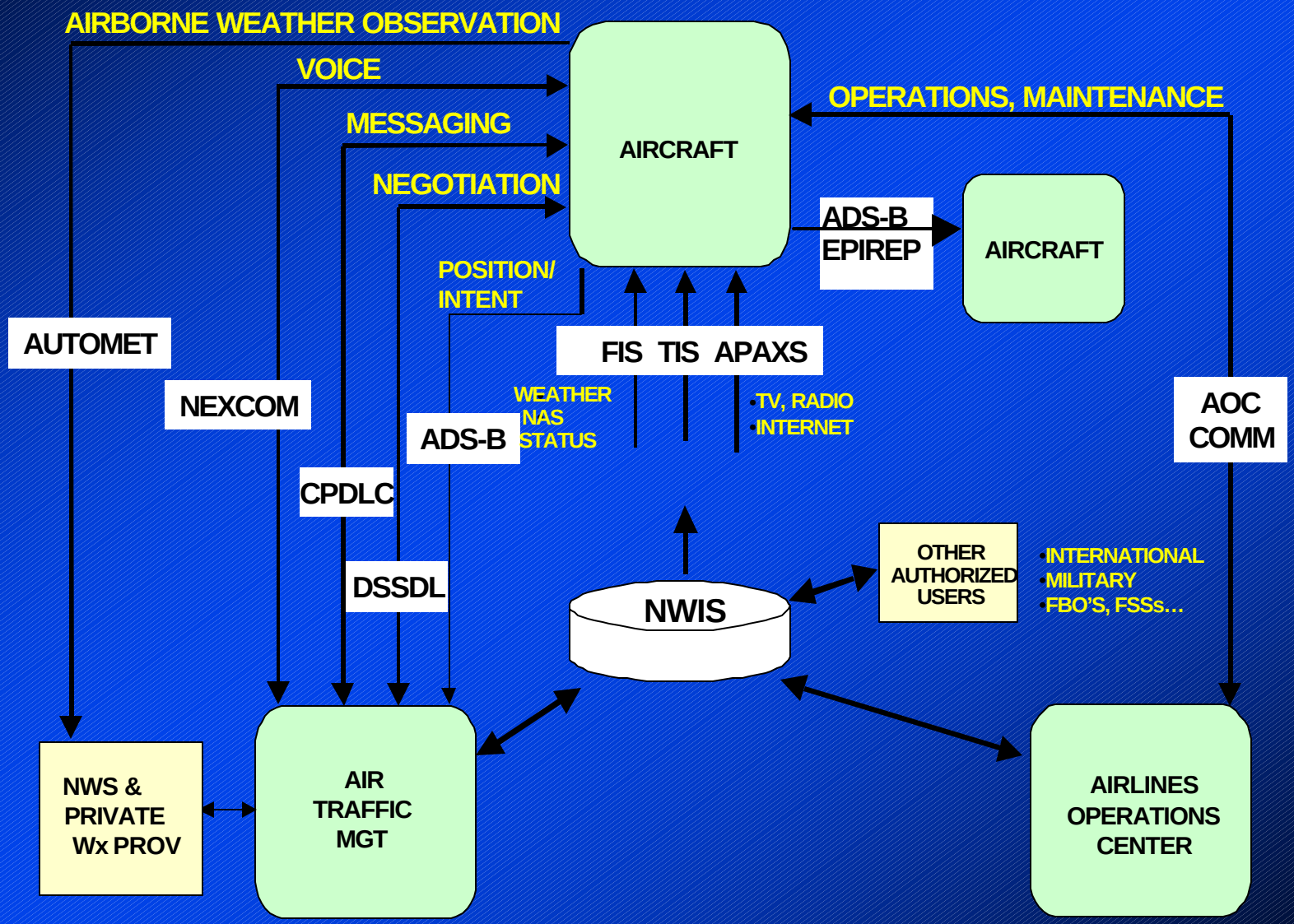
Closely spaced aircraft takeoff and landing
Reconfigurable runway/taxiway
Automated zero visibility surface movement
Small airports integrated into the NAS

ATM Automation Concepts



Integrated, strategic management of the airspace
Aircraft self-separation
Collaborative decision making

Future Information Exchange

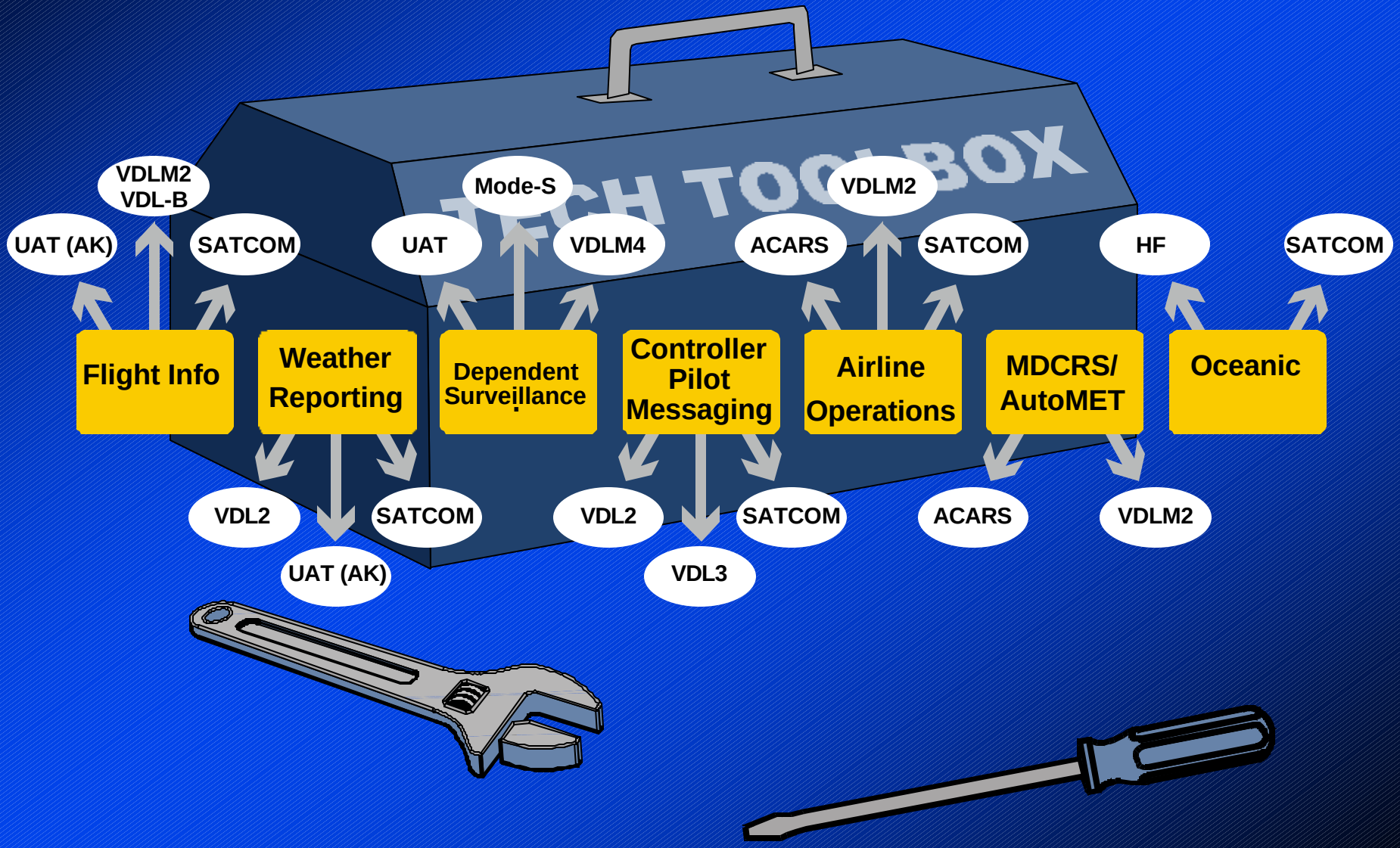


CNS Modernization Plan

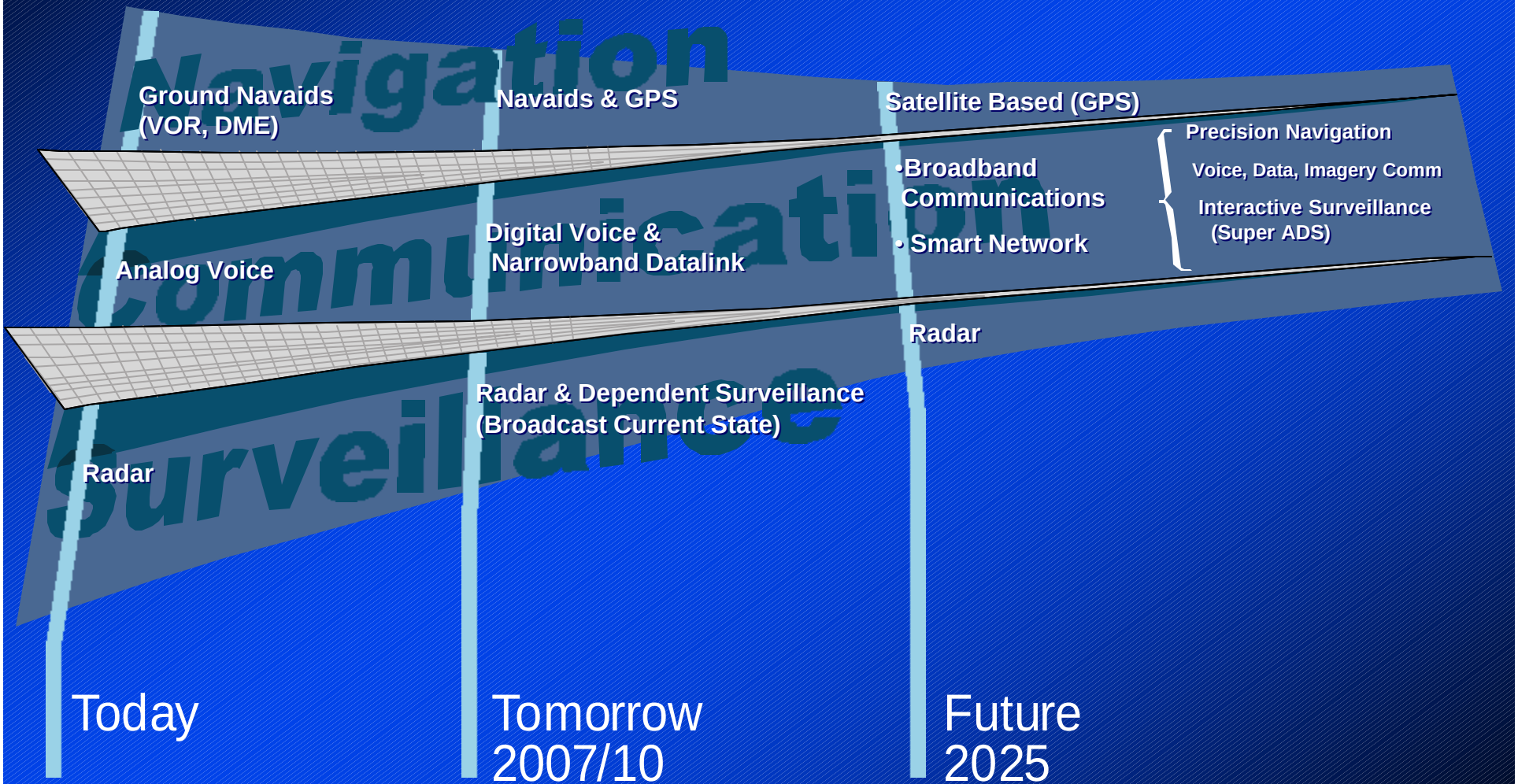
- Modernization Plans:
  - Communications:
    - Migrate to digital VHF voice & data (2010 and beyond)
  - Navigation:
    - Migrate to GPS (with augmentation systems for integrity)
    - GPS primary not sole means of navigation
  - Surveillance:
    - Migrate to dependent surveillance (vs. independent today)
    - Aircraft broadcast state information (position, velocity, etc…)

- However, the debate on the 'right' future CNS Architecture continues…
  - Comm: VDLM3, 8.33, AM + VDLM2, Satellite-based ???
  - Nav: GPS primary, sole-means, LORAN/other back-up???
  - Surv: Dependent: Mode S, UAT, VDLM4 ???
    - Keep independent surveillance radars ???

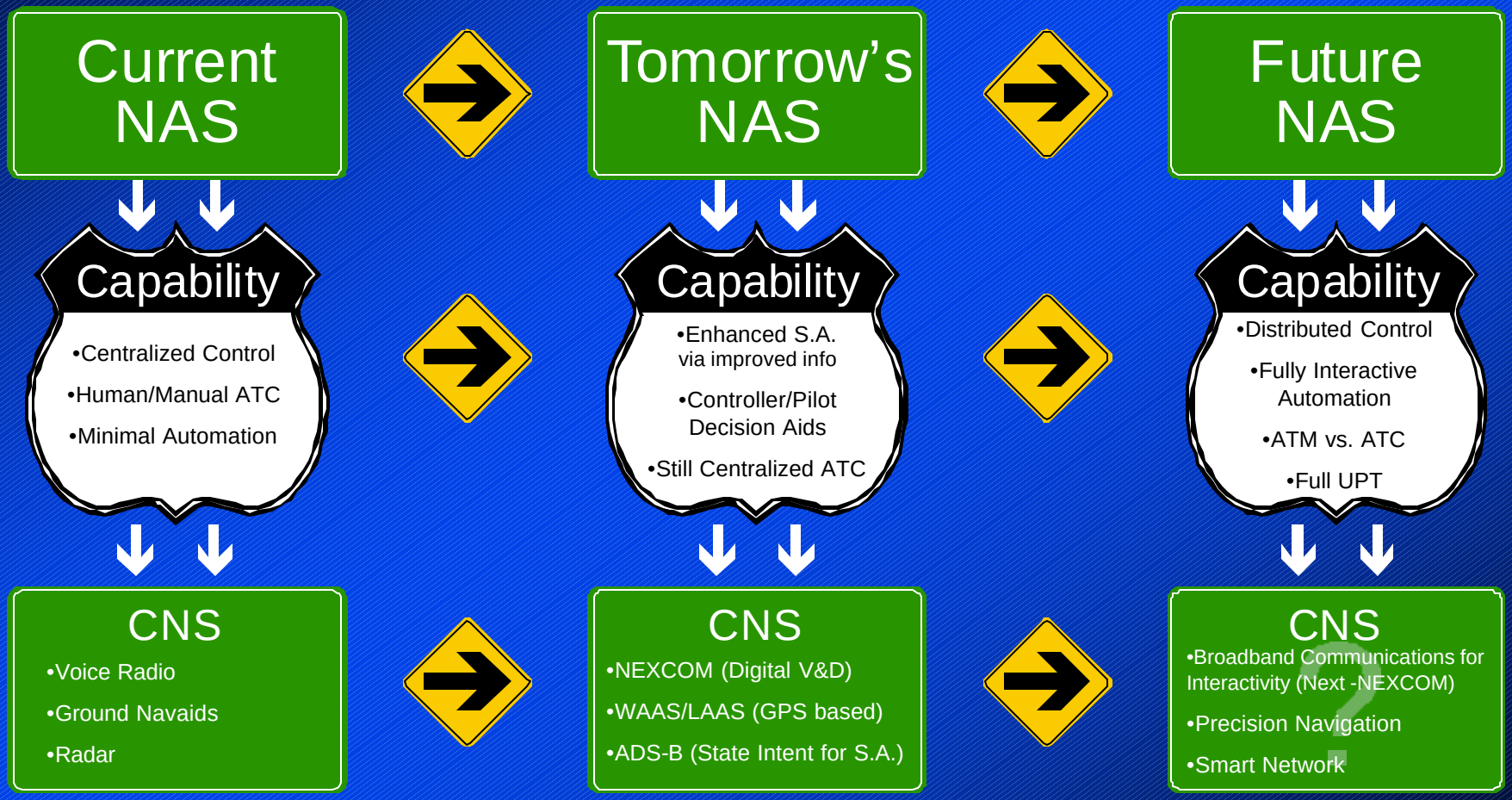
CNS Technology Stove Pipes



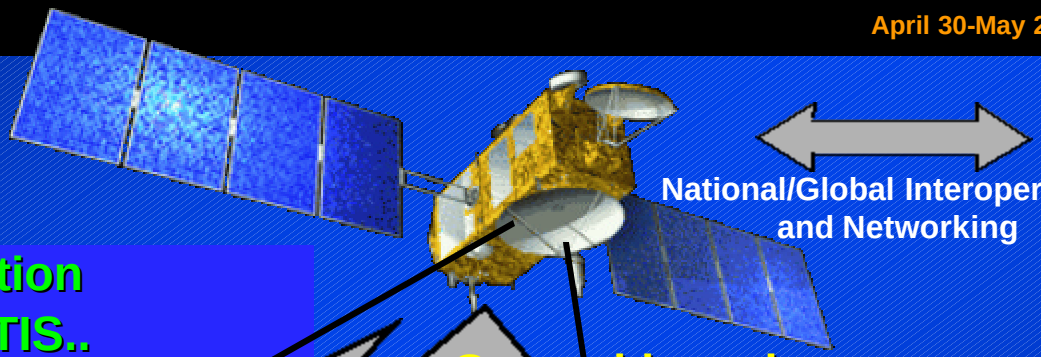
The Vision: Integrated 'C'NS



The Roadmap


Current NAS
Tomorrow's NAS
Future NAS
Capability
•Centralized Control
•Human/Manual ATC
•Minimal Automation
Capability
•Enhanced S.A. via improved info
•Controller/Pilot Decision Aids
•Still Centralized ATC
Capability
•Distributed Control
•Fully Interactive Automation
•ATM vs. ATC
•Full UPT
CNS
•Voice Radio
•Ground Navaids
•Radar
CNS
•NEXCOM (Digital V&D)
•WAAS/LAAS (GPS based)
•ADS-B (State Intent for S.A.)
CNS
•Broadband Communications for Interactivity (Next -NEXCOM)
•Precision Navigation
•Smart Network

Hybrid Integrated CNS Architecture



National/Global Interoperability and Networking

Satellite-based:

Tomorrow:

- "Big Picture" information
  - National Wx, FIS, TIS..
- Broadband broadcast

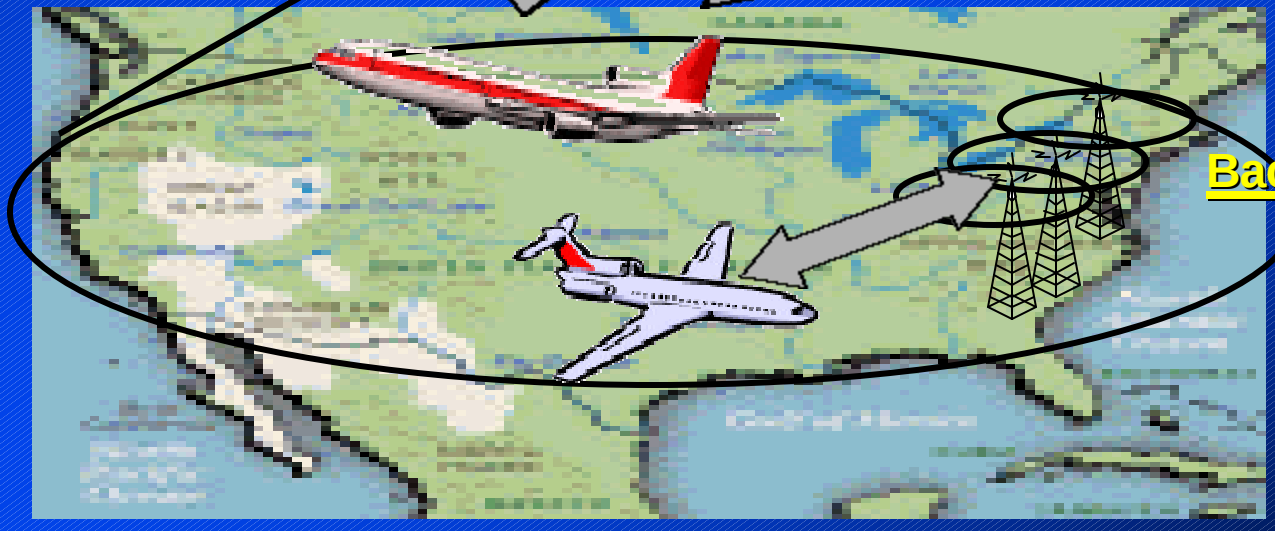
Future:

- Medium-rate return link
- Addressed info (aircraft state, security..)
- Affordable avionics ???

Ground-based:

Regional info

- Local Wx, FIS..
- Terminal area / airport ops via high-rate 2-way links
- Precision nav & surveillance

Back-up national

- Narrowband VHF for emergency comm
- Independent nav & surveillance